

## CLAIMS

1. Electric heating device comprising an electric radiator (10) for heating the air passing through it, said radiator comprising a casing (12), at least one resistive element mounted in the casing and constituted by at least one zigzag metal strip (22) which is disposed so as to be directly exposed to the air passing through the casing, and a circuit (30) for controlling the electrical supply of the resistive element or elements connected to a power supply,
- 10 characterised in that the electric radiator (10) comprises a set of individual heating modules (20) disposed parallel to one another in the casing (12) and so as to be directly exposed to the air passing through the casing, each heating module (20) comprising a pleated or corrugated metal strip (22) and an electronic switch (25) controlled by the control circuit (30) intended to selectively inhibit the electrical supply of the metal strip (22).
- 15 2. Device according to Claim 1, characterised in that each heating module (20) also comprises an electrically insulating support (40) comprising a moulded rail (45) intended to accommodate and hold in position said metal strip (22).
- 20 3. Device according to Claim 2, characterised in that the moulded rail (45) has flanges (45a, 45b) between which the tops of the corrugations are held laterally and separations (46) for maintaining a certain regularity of the pitch of the corrugated or pleated metal strip (22).
- 25 4. Device according to any one of Claims 1 to 3, characterised in that the heating module (20) comprises at least one thermal and electrical protection element, directly exposed to the air passing through the heating module and in series with the metal strip (22).
- 30 5. Device according to Claim 4, characterised in that the protection element comprises at least one hot-melt link (58) in series with a metal strip (22).
- 35 6. Device according to Claim 4, characterised in that the protection element comprises a spring blade (57) and a hot-melt link (58) formed by a brazed joint between one end of the metal strip (22) and one end of the spring blade (57), the other end of the spring blade being immovably attached to the support (40) and electrically connected to a terminal 56.

7. Device according to either one of Claims 5 and 6, characterised in that the brazed joint of the hot-melt link (58) has a melting point matching an upper temperature limit.

8. Device according to Claim 7, characterised in that the brazed joint of the hot-melt link (58) is formed by a eutectic solder joint.

9. Device according to Claim 6, characterised in that the spring blade (57) is directly exposed to the air passing through the heating module (20) and openings in the form of louvres are formed in the spring blade (57).

10. Device according to any one of Claims 6 to 9, characterised in that the spring blade (57) has a cross-section smaller than or equal to that of the metal strip (22).

11. Device according to any one of Claims 6 to 10, characterised in that the spring blade (57) has a resistivity greater than or equal to that of the metal strip (22).

12. Device according to any one of Claims 1 to 11, characterised in that a metal connection support (50) connected to the electrical power supply is integrated into the insulating support (40) allowing the electrical supply of the metal strip (22).

13. Device according to any one of Claims 1 to 12, characterised in that the electronic switch (25) is integrated onto the metal connection support (50) through tracks formed by said support.

14. Device according to either one of Claims 12 and 13, characterised in that flanges (52) are formed in the metal connection support (50) facilitating the heat dissipation of the electronic switch (25) by the air passing through the heating module (20).

15. Device according to any one of Claims 6 to 14, characterised in that the end of the spring blade (57) immovably attached to the insulating support (40) is soldered permanently to the connection terminal (56) electrically independent of the metal connection support (50) thus allowing electrical connection of the strip or of the spring blade to an external terminal or busbar (35).

16. Device according to any one of Claims 1 to 15, characterised in that each heating module (20) also comprises at least one protection mechanism of reversible or resettable type (61) connected directly or indirectly to the metal strip (22) preventing excessive heating.

17. Device according to Claim 16, characterised in that the reversible protection mechanism (61) is a thermal sensor or detector delivering information to the control circuit (30), matching the temperature of the metal strip (22) or of the spring blade (57) in order that the control circuit  
5 (30) disconnects the electrical supply in the case of excessive heating.

18. Device according to Claim 17, characterised in that the thermal sensor or detector is connected thermally to the spring blade (57).

19. Device according to either one of Claims 17 and 18, characterised in that the thermal sensor or detector comprises an element  
10 chosen from amongst an NTC resistor, a PTC resistor, a bimetallic strip and a PTC effect polymer switch.

20. Device according to any one of Claims 6 to 18, characterised in that moreover the spring blade (57) has a PTC effect thus providing the function of a thermal sensor.

15 21. Device according to any one of Claims 1 to 20, characterised in that each heating module (20) has a heating power of between 0 and 500W and preferably between 300W and 400W.

22. Device according to any one of Claims 1 to 21, characterised in that the casing (12) comprises a set of cells (14) intended to accommodate and hold in place each heating module (20).  
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23. Device according to Claim 22, characterised in that the casing (12) receives a cover (39).

24. Device according to any one of Claims 1 to 23, characterised in that the control circuit (30) comprises means of varying the power supplied by the radiator by modulating the supply voltage delivered to each heating module (20).  
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25. Device according to Claim 24, characterised in that the control circuit (30) comprises means of varying the supplied power by pulse width modulation.

30 26. Device according to any one of Claims 1 to 25, characterised in that the different heating modules (20) comprise metal strips (22) having substantially identical resistances.

27. Device according to any one of Claims 1 to 26, characterised in that each metal strip (22) of each heating module (20) has a corrugation  
35 period with a length of between 1.8 mm and 6 mm.

28. Device according to any one of Claims 1 to 27, characterised in that each metal strip (22) of each heating module has a peak-to-peak amplitude between corrugation tops of between 5 mm and 20 mm.

5 29. Device according to any one of Claims 1 to 28, characterised in that each metal strip (22) of each heating module has a width of between 5 mm and 20 mm.

30. Device according to any one of Claims 1 to 29, characterised in that each metal strip (22) of each heating module has a thickness of between 50  $\mu\text{m}$  and 250  $\mu\text{m}$  and preferably between 80  $\mu\text{m}$  and 180  $\mu\text{m}$ .

10 31. Device according to any one of Claims 1 to 30, characterised in that each metal strip (22) of each heating module is made of a material chosen from amongst an iron-based alloy and a copper-based alloy.

32. Device according to Claim 31, characterised in that the copper-based alloy is an alloy chosen from amongst CuNi30, CuNi45 and  
15 CuNi18Zn20.

33. Device according to Claim 31, characterised in that the material is an alloy having a positive temperature coefficient resistance effect.

34. Device according to any one of Claims 1 to 33, characterised in that openings in the form of louvres (26) are formed in each strip (22).

20 35. Device according to Claim 34, characterised in that the louvres (26) comprise fins (26a) which form an angle of between 20° and 35° with respect to the plane of the strip (22).

36. Device according to any one of Claims 1 to 35, characterised in that each strip (22) is provided with an electrically insulating and/or corrosion  
25 protection covering.

37. Device according to any one of Claims 1 to 35, characterised in that each metal strip (22) has a profile chosen from amongst a sinusoidal profile, a triangular profile, a rectangular profile and a trapezoidal profile.

38. Device according to any one of Claims 1 to 37, also comprising  
30 an air flow generator (7), characterised in that the electronic switches (25) driven by the control circuit (30) inhibit the electrical supply of the heating modules (20) when the air flow rate passing through the radiator (10) is below a minimum value, in order to provide protection against excessive heating.

39. Device according to Claim 38, in which the air flow generator (7) comprises a fan (3), characterised in that means are provided for supplying the control circuit (30) with a signal representing the speed of rotation of the fan in order to inhibit the electrical supply of the heating modules when the speed of rotation of the fan is below a predetermined threshold.

40. Heating or air-conditioning apparatus for a motor vehicle, characterised in that it comprises a heating device according to any one of Claims 1 to 39.

41. Apparatus according to Claim 40, characterised in that it comprises an electric radiator disposed downstream of a liquid heat exchanger in an air circulation channel.

42. Apparatus according to either one of Claims 40 and 41, characterised in that the electric radiator is disposed in proximity to an air outlet aperture.